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EFFECT OF VARIOUS ACCELERATORS ON DIFFERENT STRENGTH PARAMETERS OF M - 20 GRADE OF CONCRETE

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ABSTRACT

In this paper, researchers have presented an experimental study on concrete cubes and beams to check the impact of accelerators on the compressive and flexural strength of concrete at normal days of curing. During this experimental study ordinary Portland cement (OPC) was used to manufacture concrete mixtures M-20. Concrete mixtures for the study were designed as per the new guidelines of IS 10262:2009. 3 accelerators potassium carbonate, sodium Nitrate and calcium nitrate were used in this study and both compressive and flexural strength of specimens with different accelerators is recorded at one, three, seven, fourteen and twenty-eight days of curing with water and compared with the strengths of controlled specimens at their corresponding ages. Check the results revealed that the most percentage gain was discovered for calcium nitrite accelerator out of all accelerators at one, three, seven, fourteen and twenty-eight days compressive and flexural strength for the M-20 grade of concrete. Additionally, there's a really very little amendment in 28 days compressive strength and flexural strength with all accelerators for the M-20 grade of concrete.

KEYWORDS: Ordinary Portland Cement (OPC), Accelerators, Compressive Strength, Flexural Strength & M-20 Grade etc

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Original Article

INTRODUCTION

Concrete may be created by varying the proportions of the main ingredients or by the substitution for the cementitious and mixture phases. In recent year's strong stress placed on high early-strength and on shorter construction times. Quicker setting concrete reduces construction time for highway pavement slab replacements; but, this may be problematic due to the chance of the concrete cracking because of associated high heat generation.

The goal of this study was to see the impact of various accelerators like carbonate, sodium nitrate and calcium nitrate on the compressive and flexural strength of concrete mixture has been investigated. The expectation is that the strength is going to be higher at early ages within the mixtures that contain accelerator however consequently lower at later ages. The accelerator can increase the temperature of the concrete and is predicted to lead to higher thermal strains. These strains will result in stresses if the concrete is restrained and may result in higher cracking potentials. In addition, it's been documented that $CaCl_2$ usually will increase volumetric modification in concrete either under moist curing or drying conditions.

The objective is to check the impact of various accelerators that are potassium carbonate, sodium nitrite, calcium nitrite on compressive and flexural strength of concrete mix M20 at normal ages (1, 3,7,14 and 28 days).

LITERATURE REVIEW

Mushtaq Ahmed Bhavikatti et al. (2012) investigate the role of non-chloride hardening accelerator on the various properties of pavement, concrete at early and later age, produced with Pozzolana Cement. Compressive and flexural strengths of standard laboratory specimens, cured with water were carried out at an early age and at its full maturity. The result shows that Accelerator was extra effective in increasing the flexural strength than compressive strength of the designed concrete mix of grade M40. Maximum percentage gain in compressive strength recorded in two days of water curing with maximum dosage of the accelerator.

Vilas V. Karjinni et al. (2012) Conducted an experimental work that explains the Combined effects of a commercial, non-chloride hardening accelerator and method of curing in the strength development of pavement concrete. Ordinary Portland cement was used to produce concrete mixtures of grade M40 in this analysis. The result indicates that Interaction of the accelerator was better at three and five days in the concrete mixtures cured with water and at one day in the same mixtures cured with curing compound. The experiment shows the average efficiency of the curing compound was found to be higher at early- age than at later-age.

Mushtaq Ahmed Bhavikatti et al. (2012) Study the interaction of non-chloride hardening accelerator with ordinary Portland cement (OPC) and Portland pozzolana cement (PPC) and method of curing in the strength development of concrete mix commercial wax based membrane- forming curing compound, was used for curing in the experimental study. The result shows that the interaction of accelerator was better at three and five days in the opc mixtures cured with water and at one day in the same mixtures cured with curing compound. The average efficiency of the curing compound was found to be more for PPC mixtures than for OPC mixtures. This result shows Curing compound was more effective in PPC mixtures.

D. P. Bentz (2006) investigated the influence of three alkalies namely lithium, potassium, and sodium, on the hydration rates of cement pastes. The study showed that these three alkalies are readily soluble in water and are easily incorporated into the cement hydration products, and they modify the morphology of the calcium silicate network. The different alkali additions exhibited the common effect as an acceleration of early age hydration.

R. Duval et al. (2006) The purpose of this work is to investigate the effect of calcium nitrate, calcium nitrite, and triisopropanolamine, on the setting and hardening time of cement pastes. The results revealed both calcium nitrite and triisopropanolamine performed well as a hardening accelerator at all ages independent of the cement type used. The combination of calcium nitrate with either calcium nitrate or tri-isopropanol amine resulted in reduction in the initial and final setting process and a strength enhancement at all ages of the cement pastes, particularly at early ages. Tri-isopropanolamine is more capable in terms of increase in strength than calcium nitrite when used in equal dosage.

A. Sivakumar et al. (2002) Study the properties of Concrete that can be produced by the large replacement of cement by fly ash in a mix and with Calcium nitrate as an accelerator. Tests were conducted on different concrete specimens, where fly ash was replaced with cement up to 30%. Cement replacement up to 30% fly ash reflects an early age, strength gain slightly lower than concrete made with 20% fly ash. A higher fine-to-coarse-aggregates ratio with 1% accelerator showed higher strength at early ages.

METHODOLOGY

Ordinary Portland Cement Grade-43 conforming to IS-8112 was used. It was tested as per Indian standard specification, whose physical properties are given in Tables.

Table: 1 Physical Properties of Cement

Cement	Specific Gravity	Setting Time (minutes)		28 Days Compressive Strength (n/mm^2)
		Initial	Final	
OPC-43	3.15	85	210	44.61

Table 2: Physical Properties of Fine and Coarse Aggregates

Aggregate	Specific Gravity	Bulk Density (Loose), kg/m^3	Bulk Density (Compacted), kg/m^3
Fine	2.64	1568	1680
Coarse	2.81	1537	1666

Figure 1: Concrete Specimen for Compression Testing

Figure 2: Test Arrangements of the Specimens for Compressive Strength Results and Discussions

The compressive strength of cubes of the different grade at different days of curing is presented. A tensile strength of beams of the different grade at different days of curing is presented. Finally, the results on the effect of Potassium Carbonate, Sodium Nitrite, Calcium nitrite accelerator dosage used and compressive strength of specimens with accelerators has been recorded at one, three, seven, fourteen and twenty-eight days of curing with water and compared with strengths of control specimens at their corresponding ages will be discussed.

Accelerator I (Potassium Carbonate)

Potassium Carbonate as an accelerator used and compressive strength of cubes of grade M20 concrete are presented and tensile strength of beams of grade M20 concrete are presented at one, three, seven, fourteen and twenty-eight

days of curing with water is presented below.

Accelerator II (Sodium Nitrite)

Sodium Nitrite as an accelerator used and compressive strength of cubes of grade M20 concrete is presented and tensile strength of beams of grade M20 concrete is presented as one, three, seven, fourteen and twenty-eight days of curing with water is presented below.

Accelerator III (Calcium nitrite)

Calcium nitrite as an accelerator used and compressive strength of cubes of grade M20 concrete is presented and tensile strength of beams of grade M20 concrete is presented as one, three, seven, fourteen and twenty-eight days of curing with water is presented below.

RESULTS

Table 3: Gain in Compressive Strength of M-20 at Different Days of Curing using Accelerator I Potassium Carbonate

	Mix M-20 Nominal Mix	Accelerator I Potassium Carbonate	Percentage (%) Increase in Compressive Strength
1	13.67	14.45	5.705
3	15.74	17.22	9.4
7	20.615	22.54	9.337
14	24.48	25.77	5.264
28	27.15	27.51	1.325

Table 4: Gain in Compressive Strength of M-20 at Different Days Of Curing Using Accelerator II Sodium Nitrite

	Mix M-20 Nominal Mix	Accelerator II Sodium Nitrite	Percentage (%) Increase in Compressive Strength
1	13.67	15.85	15.94
3	15.74	19.62	24.66
7	20.615	24.37	18.215
14	24.48	27.63	12.867
28	27.15	28.93	6.556

Table 5: Gain in Compressive Strength of M-20 at Different Days of Curing using Accelerator III Calcium Nitrite

	Mix M-20 Nominal Mix	Accelerator III Calcium Nitrite	Percentage (%) Increase in Compressive Strength
1	13.67	17.09	25.03
3	15.74	21.09	33.989
7	20.615	25.27	22.58
14	24.48	28.59	16.789
28	27.15	29.61	9.06

Table 6: Percentage Increase in Compressive Strength of M-20 at Different Days of Curing using All Three Accelerators

	Accelerator I Potassium Carbonate	Accelerator II Sodium Nitrite	Accelerator III Calcium Nitrite
1	5.705	15.94	25.03
3	9.4	24.66	33.989
7	9.337	18.215	22.58
14	5.264	12.867	16.789
28	1.325	6.556	9.06

Table 7: Gain in Flexural Strength of M-20 at Different Days Of Curing Using Accelerator I Potassium Carbonate

	Mix M-20 Nominal Mix	Accelerator I Potassium Carbonate	Percentage (%) Increase in Flexural Strength
1	1.24	1.296	4.516
3	1.613	1.695	5.08
7	2.163	2.243	3.69
14	2.564	2.624	2.34
28	3.016	3.078	2.05

Table 8: Gain in Flexural Strength of M-20 at Different Days Of Curing using Accelerator II Sodium Nitrite

	Mix M-20 Nominal Mix	Accelerator II Sodium Nitrite	Percentage (%) Increase in Flexural Strength
1	1.24	1.334	7.58
3	1.613	1.724	6.88
7	2.163	2.318	7.165
14	2.564	2.723	6.2
28	3.016	3.164	4.93

Table 9: Gain in Flexural Strength of M-20 at Different Days Of Curing using Accelerator III Calcium Nitrite

	Mix M-20 Nominal Mix	Accelerator III Calcium Nitrite	Percentage (%) Increase in Flexural Strength
1	1.24	1.417	14.27
3	1.613	1.803	11.77
7	2.163	2.374	9.75
14	2.564	2.787	8.69
28	3.016	3.195	5.935

Table 10: Percentage Increase in Flexural Strength of M-20 at Different Days of Curing using All Three Accelerators

	Accelerator I Potassium Carbonate	Accelerator II Sodium Nitrite	Accelerator III Calcium Nitrite
1	4.516	7.58	14.27
3	5.08	6.88	11.77
7	3.69	7.165	9.75
14	2.34	6.2	8.69
28	2.05	4.93	5.935

Table 11: Gain in Flexural Strength of M-20 at Different Days Of Curing using Accelerator Ii Sodium Nitrite

	Mix M-20 Nominal Mix	Accelerator II Sodium Nitrite	Percentage (%) Increase in Flexural Strength
1	1.24	1.334	7.58
3	1.613	1.724	6.88
7	2.163	2.318	7.165
14	2.564	2.723	6.2
28	3.016	3.164	4.93

Table 12: Gain in Flexural Strength of M-20 at Different Days Of Curing using Accelerator III Calcium Nitrite

	Mix M-20 Nominal Mix	Accelerator III Calcium Nitrite	Percentage (%) Increase in Flexural Strength
1	1.24	1.417	14.27
3	1.613	1.803	11.77
7	2.163	2.374	9.75
14	2.564	2.787	8.69
28	3.016	3.195	5.935

Table 13: Percentage Increase in Flexural Strength of M-20 at Different Days of Curing using All Three Accelerators

	Accelerator I Potassium Carbonate	Accelerator II Sodium Nitrite	Accelerator III Calcium Nitrite
1	4.516	7.58	14.27
3	5.08	6.88	11.77
7	3.69	7.165	9.75
14	2.34	6.2	8.69
28	2.05	4.93	5.935

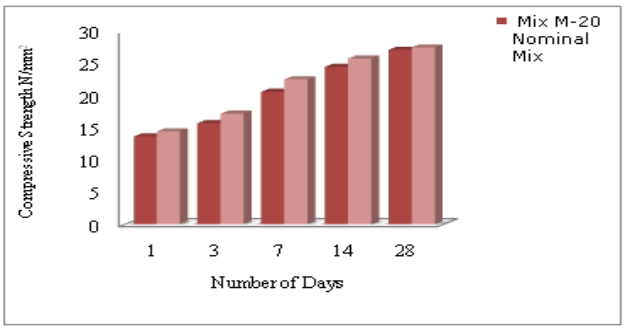

Figure 3: Gain in Compressive Strength of Mix M-20 with Accelerator I

The figure is plotted between gain in compressive strength of Mix M20 used with accelerator Potassium carbonate with the comparison of the Nominal Mix M20 and presented as one, three, seven, fourteen and twenty-eight days of curing with water.

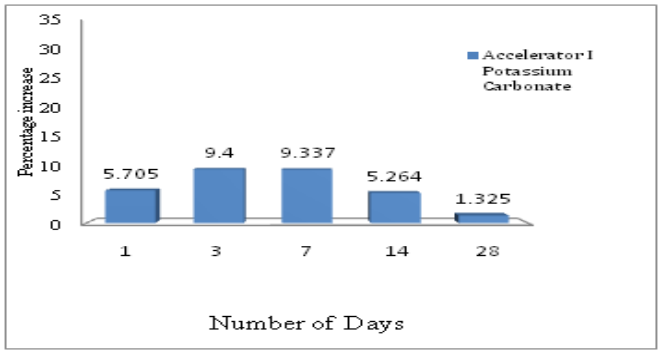

Figure 4: Percentage Increase in Compressive Strength of Mix M-20 with Accelerator I

The figure is plotted between Percentage increase in compressive strength of Mix M20 used with accelerator Potassium carbonate with the comparison of the Nominal Mix M20 and presented as one, three, seven, fourteen and twenty-eight days of curing with water. It observed that 5.705 % increase in compressive strength of specimen at one day of curing and overall 1.325 % increase in compressive strength of a specimen in twenty-eight days of curing using accelerator Potassium carbonate.

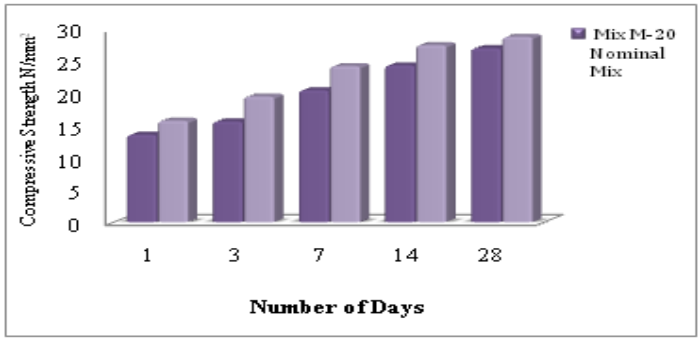

Figure 5: Gain in Compressive Strength of Mix M-20 with Accelerator II

The figure is plotted between gain in compressive strength of Mix M20 used with accelerator Sodium Nitrite with the comparison of the Nominal Mix M20 and presented as one, three, seven, fourteen and twenty-eight days of curing with water.

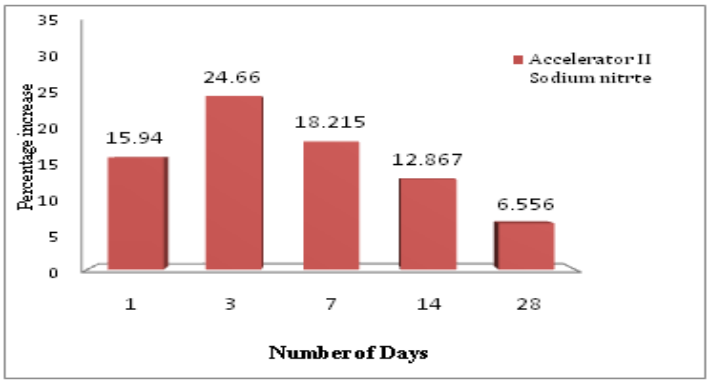

Figure 6: Percentage Increase in Compressive Strength of Mix M-20 with Accelerator II

The figure is plotted between Percentage increase in compressive strength of Mix M20 used with accelerator

Sodium Nitrite with the comparison of the Nominal Mix M20 and presented as one, three, seven, fourteen and twenty-eight days of curing with water. It observed that 15.94 % increase in compressive strength of specimen at one day of curing and overall 6.556 % increase in compressive strength of a specimen as twenty-eight days of curing using accelerator Sodium Nitrite.

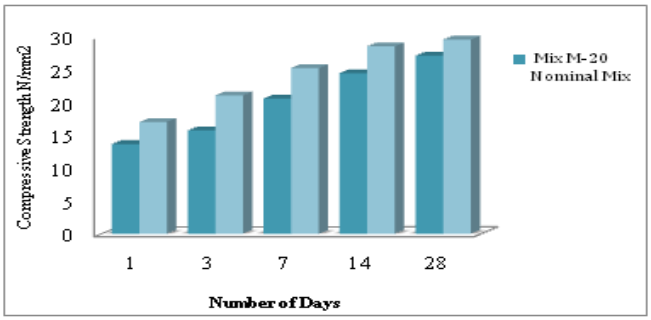

Figure 7: Gain in Compressive Strength of Mix M-20 with Accelerator III

The figure is plotted between gain in compressive strength of Mix M20 used with accelerator Calcium nitrite with the comparison of the Nominal Mix M20 and presented as one, three, seven, fourteen and twenty-eight days of curing with water.

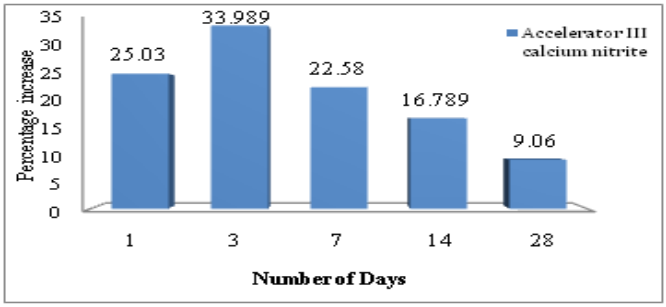

Figure 8: Percentage Increase in Compressive Strength of Mix M-20 with Accelerator III

The figure is plotted between Percentage increase in compressive strength of Mix M20 used with accelerator Calcium nitrite with the comparison of the Nominal Mix M20 and presented as one, three, seven, fourteen and twenty-eight days of curing with water. It observed that 25.03% increase in compressive strength of specimen at one day of curing and overall 9.06 % increase in compressive strength of a specimen as twenty-eight days of curing using accelerator Calcium nitrite.

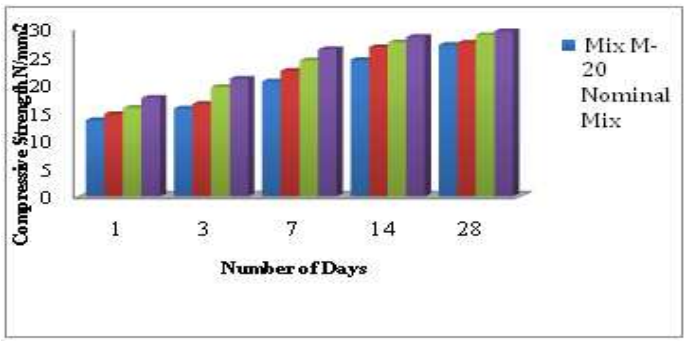

Figure 9: Gain in Compressive Strength of Mix M-20 with Accelerator I, II, III

The figure is plotted between gain in compressive strength of Mix M20 used with accelerator Potassium carbonate, sodium nitrite and Calcium nitrite, with the comparison of the Nominal Mix M20 and presented as one, three, seven, fourteen and twenty-eight days of curing with water.

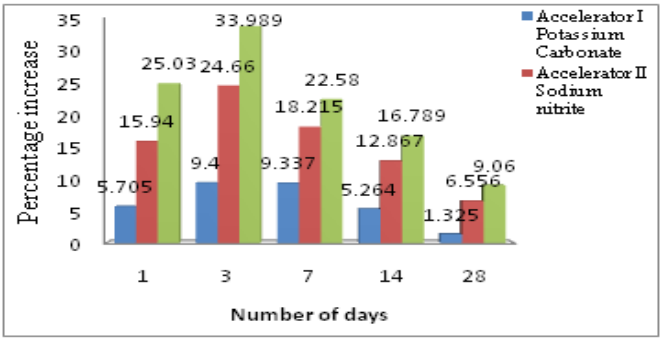

Figure 10: Percentage Increase in Compressive Strength of Mix M-20 with Accelerator I, II, III

The figure is plotted between Percentage increase in compressive strength of Mix M20 used with accelerator Potassium carbonate, sodium nitrite and Calcium nitrite with the comparison of the Nominal Mix M20 and presented as one, three, seven, fourteen and twenty-eight days of curing with water.

CONCLUSIONS

- The maximum percentage gain was observed for **Calcium nitrite** accelerator out of all accelerators at 1, 3, 7, 14 and 28 days Compressive Strength for both M20 Grade of Concrete.
- There is a very little change in 28 days compressive strength with all accelerators for both M20 Grade of Concrete.
- Maximum percentage gain in compressive strength was more than thirty percent, recorded at Three days of curing with accelerator calcium nitrite in M20.
- The maximum percentage gain was observed for **Calcium nitrite** accelerator out of all accelerators at 1, 3, 7, 14 and 28 days Flexural Strength for both M20 Grade Concrete.

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